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RFID Benefits; Looking Beyond ROI

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December 2005

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We explore whether benefits are being realized in RFID initiatives that are not being captured by traditional Return on Investment analysis. Utilizing the Naval Supply System Report, which found RFID technology does not create a positive ROI, we surveyed the participants to find benefits they received that were not addressed. 100% of the participants reported increased customer knowledge and increased timeliness of information. While this finding may not be enough to support the implementation of new technologies, it at least supports the idea that the new technologies do have real benefits. This report is therefore intended as a tool to be used by the Navy in addressing the idea that traditional ROI does not capture these intangible benefits. We acknowledge the fact that further study of this important issue is needed.

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RFID BENEFITS; LOOKING BEYOND ROI

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Submitted in partial fulfillment of the requirements for the degree of

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RFID BENEFITS; LOOKING BEYOND ROI

ABSTRACT

This MBA project seeks to verify that benefits are being captured in RFID initiatives that are not being captured by traditional Return on Investment analysis. Utilizing the Naval Supply System Report, which found RFID technology does not create a ROI), we surveyed the participants to find benefits they received that were not addressed. 100% of the participants reported increased customer knowledge and increased timeliness of information. While this finding is not enough to implement new technologies, it supports the idea that the new technologies do have real benefits and will point practitioners in the right direction. This paper is therefore intended as a tool to be used by the Navy in addressing the idea that traditional ROI does not capture these intangible benefits. We acknowledge the fact that further study of this important issue is needed

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TABLE OF CONTENTS

I. INTRODUCTION 1
A. PURPOSE 1
B. BACKGROUND 1
C. 2 X 2 WALMART 2
D. WHAT ARE THE TECHNOLOGIES? 3
E. DOD BCA 5
F. NAVSUP BCA 6
G. FORMAT OF THIS PAPER 6
II. INFORMED FOUNDATION 7
A. THE NEED FOR SPEED 7
B. TOTAL ASSET VISIBILITY 8
C. AUTOMATED INFORMATION SYSTEMS 9
D. DOD RFID MANDATE 9
E. PARTNER WITH INDUSTRY 11
F. INDUSTRY DRIVER 11
G. THE VALUE OF LOGISTICS INFORMATION 12
H. ADVANCED TECHNOLOGY ORDINANCE SURVEILLANCE (ATOS) 12
I. PUTTING VALUE TO THE INTANGIBLES 13
III. INTANGIBLE BENEFITS 15
A. INTRODUCTION 15
B. THE INTANGIBLES 15
1. Increased Worker Satisfaction 15
2. Real Time Information 15
3. Resident Expertise in New Technology 16
4. Increased Customer Confidence 16
5. Unforeseen Opportunities 16
6. Information System Consolidation 16
7. Improved Quality Control 17
C. CONCLUSIONS 17
IV. METHODOLOGY 19
A. INTRODUCTION 19
B. THE PARTICIPANTS 19
C. DATA COLLECTION 19
D. DATA COLLECTED 20
V. FINDINGS 21
A. PRELIMINARY DATA 21
B. SPECIFIC BENEFITS 24
VI. ATTRIBUTES CONTRIBUTING TO SYSTEM PERFORMANCE 33
A. EXPLORING VARIABILITY 33

B. AN OPERATIONS APPROACH TO SYSTEM PERFORMANCE........35
C. TECHNICAL PERFORMANCE........36
1. Attributes of the Technology........36
2. Functionality Required........37
3. Environmental Factors........39
D. SYSTEM AVAILABILITY........40
1. Reliability........40
2. Maintainability........42
3. Durability........42
4. Product Availability........43
E. TECHNICAL RELIABILITY........44
1. Technical Reliability........44
2. Choosing the Right Technology........44
F. PROCESS EFFICIENCY........45
1. Business Operations........45
2. Personnel........45
3. Logistical Application........46
4. Integration........46
G. SYSTEM PERFORMANCE........47

VII. DATA ANALYSIS........49
A. WHAT CAN WE LEARN?........49
B. THE INITIATIVES........50
1. Initiatives Not Implemented........50
2. Submitted For Further Evaluation........52
3. Not Complete Yet........53
4. Implemented........53
C. EVERYONE RECEIVES........56
D. SUMMARY........57

VIII. CONCLUSIONS AND IMPLICATIONS........59
A. FINDINGS........59
B. IMPLICATIONS........59

LIST OF REFERENCES........63

INITIAL DISTRIBUTION LIST........67

LIST OF FIGURES

Figure 1. Wal-Mart 2
Figure 2. The family of AIT technologies 3
Figure 3. RFID BCA 2005 Findings 6
Figure 4. What was the purpose 21
Figure 5. Which technology was evaluated 22
Figure 6. Initiative Status 23
Figure 7. Were other technologies considered? 24
Figure 8. Process Improvement Reported 25
Figure 9. Supply System Information Reported 26
Figure 10. Manpower Benefits Reported 27
Figure 11. Parts Information Reported 28
Figure 12. Customer Service Reported 29
Figure 13. NAVSUP Read Rate Ranges 34
Figure 14. System Performance from an Ops Management View 35
Figure 15. Attributes: Bar Code versus RFID, (Wyld 2005) 36
Figure 16. RFID Operating Frequencies, Wyld (2005) 39
Figure 17. Status of Initiatives 49

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LIST OF TABLES

Table 1. Raw Benefits Results 30
Table 2. Summary of Findings 57

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I. INTRODUCTION

A. PURPOSE

The purpose of our MBA project is explore whether benefits are received from implementing RFID into the logistics process that are not captured through traditional return on investment (ROI) analysis. We seek to identify some of these benefits to determine their overall contribution to the value of implementing technology. If these benefits are verified by further research, then decision makers can taken them into account when determining whether to implement new technologies.

Our research question evolves from the premise that the ROI in the Department of Defense (DOD) is based on costs, with no reference to benefits. In non-profit organizations there are no direct profits to be measured from implementing new technologies. Without profits the “revenues” (i.e., benefits) side of the ROI equation is often ignored. By identifying benefits received in excess of the cost savings we hope to introduce the idea that the traditional ROI has blind spots when used in non-profit organizations.

We utilize data from the participants in the Naval Supply Systems Command (NAVSUP) Radio Frequency Identification (RFID) pilots. Our project is intended for the Navy leadership primarily as a guide to further investigation. The limited quantity of data makes any finding statistically non supportable, but nonetheless starts to provide an interpretive perspective that expands beyond the traditional “bottom line”.

B. BACKGROUND

In 2000 the DOD mandated the use of Automatic Identification Technologies (AIT) in logistics (DOD 2000) and has continued to refine this concept mandating the use of RFID in 2003 (DOD 2003), providing a long-term plan of technology implementation. The near term goals of the RFID initiative includes vendors and the Defense Logistics Agency (DLA) tagging pallet and case level materials intended for DOD activities.

At the same time the DOD initiatives are taking place, Wal-Mart has directed a mandate of their own. They have required their top 100 suppliers to tag all incoming

cases with passive RFID. Wal-Mart is not paying for the suppliers to do this, but is rather making it a cost of doing business with the world's largest retail store.

Response to this mandate has ranged from embracing the technology to "slap and stick" applications, which means they will tag the item but are not interested in adopting RFID at their company. Wal-Mart is not concerned about why they apply the tags, only that they comply.

What does Wal-Mart expect to gain from implementing RFID? What about the Department of Defense?

C. 2 X 2 WALMART

Value of <u>Capability Increases</u>	**Source of payoff** **Increased sales deriving from capability of using RFID data to increase on-shelf availability.** **Tangible $$ value**	**Source of payoff** **Increased War-fighting capability** **Not Quantified**
Value of <u>Cost Decreases</u>	**Source of Payoff** **Inventory cost savings derived from reducing the bullwhip effect, based on better data on physical inventory derived from RFID.** **Tangible $$ value**	**Source of Payoff** **Inventory cost savings derived from reducing the bullwhip effect, based on better data on physical inventory derived from RFID.** **Tangible $$ value**
	COMMERCIAL SECTOR	**DOD SECTOR**

Figure 1. Wal-Mart

This 2X2 matrix was developed by Nick Dew [Dew 2005] and presents a good contrast between the commercial sector and the DOD in terms of the benefits to be obtained from implementing new technologies. In the simplest terms, the cost benefits targeted by both sectors are very similar, that is to lower cost by lowering inventory,

lowering labor requirements, etc. The traditional model of ROI is to take the expected present value of returns (benefits – e.g,, profits) divided by the expected present value of all outlays (costs).

The problem with the DOD model is that it only addresses cost factors – traditionally placed in the denominator – with cost reductions, and even 'cost avoidance' often put into the numerator as surrogates for 'benefits'. The problem for DOD is addressing the numerator – the true benefits, in terms of mission capabilities realized by the investment. What are the benefits derived from implementing technology that can give us an actual ROI?

To begin the process of specifying these benefits we will identify the technologies that are being addressed in this paper. The selection of these technologies comes from the specific applications being researched by NAVSUP. Although there are several technologies we will examine, we are most interested in the benefits of RFID.

D. WHAT ARE THE TECHNOLOGIES?

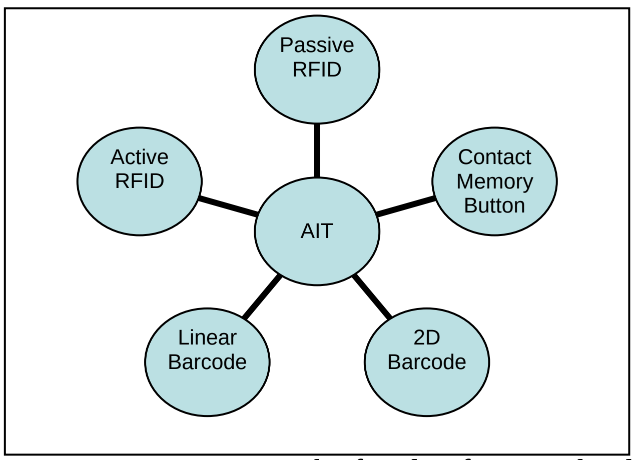

Figure 2. The family of AIT technologies

This family of AIT is currently being utilized in numerous initiatives that are attempting to identify the relevant capabilities where they can be applied. Here are the definitions of the technologies as they are applied throughout this paper.

AIT – Automatic Identification Technologies, "a suite of technologies enabling the automatic capture of source data, to enhance the ability to identify, track, document

and control material, maintenance processes, deploying and redeploying forces, equipment, personnel, and sustainment cargo." (NAVSUP 2004)

Linear Barcode is the standard technology currently in use for all retail operations. The black and white lines represent 17-20 digits which comprise a unique identification for the material. As the most stable technology, it will experience one error in 3.4 million reads. (NAVSUP 2004)

2D Barcodes are an improved barcode which carry approximately 100 more digits. They are extremely reliable, with only one error seen every 7.1 million reads. They can be read when partially torn and are currently used on the military ID card. (NAVSUP 2004)

Contact Memory Buttons (CMB) are

> a compact device the size of a watch battery, a contact memory button is something like a floppy disk in a can. CMBs cost 600 times more than bar codes but can store up to 64 Kilobytes of information, and will survive most types of environmental damage. CMBs are especially useful in applications where space is limited and access to current data is critical. (NAVSUP 2004)

Active RFID "can remotely identify, categorize, and locate materiel automatically (i.e., without human intervention). When used in conjunction with hand-held interrogators, RFID tags provide "in the box" visibility. Data is digitally stored on RFID tags (radio transceivers with memory units). Data capacity of the tag is up to 128 Kilobytes and information can be retrieved from distances of up to 300 feet away using strategically placed electronic interrogators to identify their exact location and relay the data via wired or wireless technology" (NAVSUP 2004).

Passive RFID - Small passive tags are used in clothing stores to assist in detecting shoplifters. The memory of Passive Read/Write Tags ranges from 48 Bytes to 736 Bytes (Escort 2001). This tag differs from active tags by requiring external activation which generates sufficient power to transmit a return signal. This capability is far less expensive than the active tag but has a short read range and data capacity is small (NAVSUP 2004).

The attraction of these technologies to DOD is found in the definition of AIT. They are enablers that can have many positive benefits in the logistics arena. In warehousing operations they can dramatically simplify inventory and tracking requirements and increase accuracy of receipts and shipments. These technologies have been around for a number of years but the application to the logistics chain is relatively new. These new applications present unique challenges for the technologies.

The overarching guidance for implementing this technology comes from the DOD. The DOD case is provided below.

E. DOD BCA

In 2000 the DOD directed the adoption of AIT in logistics (DOD 2000). This mandate was followed in 2004 by RFID Business Practices which outlined the timeline for application of RFID within the DOD.

In January 2005 DLA reported a "Business Case Analysis (BCA) for Passive RFID" (DLA 2005) to a DOD AIT Integrated Product Team (IPT). In this presentation they presented a ROI that ranged from $70 million pessimistically to $1.78 billion optimistically. The sources of these savings were as follows:

Reduced shipping losses

Reduced inventory losses

Reduced duplicate order issuing costs

Reduced duplicate order transportation costs

Reduced labor costs

These numbers present a strong case that a positive ROI could realistically be expected in the near term from implementing RFID. While this material was being presented NAVSUP was preparing its own BCA based on ongoing initiatives within the Navy supply system.

F. NAVSUP BCA

The Navy supply system has been running AIT initiatives for a number of years. They presented their collective finding in a BCA in July 2005. The findings of the RFID initiatives were summarily reported in the following bullets:

1. RFID tag read rates are unreliable: (range 92% to 38% thru the supply chain).

2. Total implementation costs are high: ($53M to $123M ashore / $228M afloat).

3. Benefits are scarce and notional at best. Current ROI calculations will require pilot and/or prototype confirmation: Labor savings ($35M to $96M ashore / none afloat). Inventory savings ($118M (compliance) to $495M (SAP)).

4. Break Even: Ashore: Best case in 5 to 6 years
Worst case in 6 to 7 years
Afloat: None

Figure 3. RFID BCA 2005 Findings

NAVSUP, like DOD, reports findings in terms of cost reductions. In a similar manner to DOD, NAVSUP reported the value of the technology in terms of labor savings and inventory savings. The fact that both studies found the value in the lower right quadrant of our Wal-Mart 2x2 justified our question and embarked us on this quest.

We will now report on an extensive literature review that was conducted to collect information on the technology, its applications, its capabilities and its limitations in order to attempt to define the readiness values associated with implementing AIT technology in the supply chain.

G. FORMAT OF THIS PAPER

The outline of this paper will begin with a literature review to create the underlying foundation of this study. We will then look at indirect benefits and the foundation of our belief that they exist. We will then discuss the methodology and findings of our research, which will be followed by an evaluation of RFID from an operational perspective. We will finish up by looking at future capabilities as they relate to these technologies and then have our conclusions.

II. INFORMED FOUNDATION

A. THE NEED FOR SPEED

The weakness of any supply chain can be traced to the disconnect between the material and the information. The lack of information and visibility of order status, inventory levels and delivery times can cause confusion in a supply chain. This confusion can lead to out of stocks or overstocking to ensure item availability. To be successful the supply chain depends on up to date, accurate, real time information.

The DOD realized this need and as a result the Defense Material Management Regulation, DOD 4140.1R, was updated in 1993 to show the growing importance of AIT. The regulation required the DOD components to incorporate and maximize the use of machine-readable AIT devices within collection devices, and to consider AIT as the preferred system for input and data collection (DOD 2003).

AIT is defined as a group of technologies enabling the automatic capture of source data which will enhance the ability to identify, track, document, and control the movement of cargo (Stewart, 2004). AIT uses a variety of different storage media to capture and store asset data, and can provide the data electronically to logistics automated information systems to better achieve Total Asset Visibility (TAV) while streamlining business processes and warfighting capabilities (DOD IPLAIT, 2000). AIT minimizes human intervention in the collection and transfer of data, therefore increasing productivity and reducing the possibility of error.

Four years later the Deputy Undersecretary of Defense for Logistics (DUSD(L)) saw a need for one group to focus the efforts and head the advancement of the DOD's AIT effort. This led to the establishment of the DOD Logistics AIT Task Force in January 1997. That team's purpose was to develop a logistics AIT Concept of Operations (CONOPS). The CONOPS which was published in November 1997 emphasized the development of interoperable AIT media and the infrastructure to support asset visibility and logistics operations.

In March of 2000 the DOD went forward with the next step in the plan for improving supply chain logistics. The Implementation Plan for Logistics Automatic Identification Technology was approved and put into immediate action. This plan built on the foundation that the CONOPS had laid three years earlier.

> According to the Implementation Plan,
>
> …the DOD seeks to integrate AIT into logistics business processes to facilitate the collection of initial source data, reduce processing times, improve accuracy, and enhance asset visibility. AIT devices will be applied to support business processes as well as the AIT requirements of all users in the DOD logistics chain (DOD IPLAIT, March 2000).

B. TOTAL ASSET VISIBILITY

The DUSD(L) established the Joint Total Asset Visibility (JTAV) Office in April 1995 with the goal of providing the Combatant Commanders and Joint Task Force Commanders an overall view of theater assets (JTAV PMP, 2001). The JTAV Program Management Plan defines total asset visibility as the "capability for users to view information on the identity and status of DOD material assets and in some cases, complete a business transaction using the information".

TAV includes three main areas: in-storage, in-process, and in-transit (JTAV PMP, 2001). In-storage TAV includes wholesale and retail assets held as inventory. Warehouse Management Systems enable automated tracking in this area. In-process TAV includes assets in maintenance or procurement. Order Management Systems enable the automated tracking of inventory during this phase. In-transit assets are assets that have been shipped to a destination. These assets can be tracked using Transportation Management systems.

Besides providing more efficient and effective logistics system capabilities, JTAV strives to provide material identification from systems using AIT to improve the warfighter's ability to identify in-transit or in-storage assets (JTAV PMP, 2001).

In-transit visibility (ITV) is the subset of TAV that focuses on tracking the identity, status, and location of cargo from origin to destination. Critical areas of ITV

include data received for supplies, equipment, identification of cargo and distribution of assets in the transportation process (JP 4-01.8, 2000). This is where RFID enters the picture.

C. AUTOMATED INFORMATION SYSTEMS

Once the assets have been identified with the AIT, the information is used in Automated Information Systems (AIS). AIS's interface with commercial transportation information systems to receive and pass cargo movement data and other transportation information to the appropriate organizations throughout the defense transportation system (FM 55-80). An alternate definition identifies AIS as an automated command and control system that implements the exchange of information among the Combatant Commanders, the Services, and the functional component commands, with a goal of providing up to date and accurate battlefield knowledge (JP 4-01.8, 2000).

There is a variety of different media and supporting technologies that can provide TAV. RFID and its capabilities will be the focus of this report.

D. DOD RFID MANDATE

RFID first appeared in tracking applications during the 1980s and has been established in a wide range of markets due to its ability to track moving objects. The Acting Under Secretary of Defense (Acquisition, Technology, and Logistics), Michael W. Wynne, published a memorandum in October 2003 establishing policy for the use of RFID within the DOD. The memorandum directed the following:

> Implementation, within our business processes, of the active RFID tags currently used in the DOD operational environment to meet Combatant Commander TAV requirements in the following ways:
>
> 1. Sustainment Cargo: All Layer 4 Freight Containers and palletized sustainment shipments must have active RFID tags written with content level detail and applied at the point of origin.
>
> 2. Unit Movement Cargo and Equipment: All Layer 4 Freight Containers and palletized sustainment shipments must have active RFID tags written with content level detail and applied at the point of origin.

> 3. Ammunition Shipments: All Layer 4 Freight Containers and palletized sustainment shipments must have active RFID tags written with content level detail and applied at the point of origin.
>
> 4. Prepositioned Material and Supplies: All prepositioned stocks of War Reserve Materials not already issued must have active RFID tags written with content level detail and applied at the point of origin.
>
> 5. RFID Tags: All active RFID tag files will be written with content level detail in accordance with approved format and sent to the regional ITV servers for further transmission to GTN and other global asset visibility systems as appropriate (Wynne, 2003).

A second, updated policy letter was published on 20 February 2004, with the following changes and additions:

> 1. DOD Components will continue their maximum effort to immediately implement and expand the use of active RFID tags currently employed in the DOD operational environment.
>
> 2. DOD Components will plan for a 1 January 2005 implementation of the passive RFID business rules.
>
> 3. DOD suppliers must put passive RFID tags on the cases and pallets of materiel shipped to the DOD, as well as on the packaging of all items requiring a Unique Identification.
>
> 4. DOD Components will establish an initial capability to read passive RFID tags and use the data at key sites by January 2005.
>
> 5. All new solicitations issued after 1 October 2004 for delivery in 2005 will require passive RFID tagging at the case, pallet, and Unique Identification packaging level."

Secretary Wynne notes in this policy letter that an RFID enabled DOD supply chain "will provide a key enabler for the asset visibility support needed by our warfighters" (Wynne, 2004). The memo did not specify how the warfighting benefits derived from better asset visibility were to be measured.

E. PARTNER WITH INDUSTRY

Last year, the DOD announced it hired IBM Business Consulting Services under a three-year, $8.4 million contract, to manage and support the new RFID policy. IBM will assist with finalizing the DOD's RFID policy and will help with policy execution. IBM will also be responsible for identifying commercial best practices, developing business rules, educating suppliers, and preparing DOD units for implementation (French, 2004).

DOD has placed high importance on RFID implementation. In each memo, Secretary Wynne highlighted the importance of RFID implementation to warfighter asset visibility. He stated "RFID will improve…item management and asset visibility" and "RFID…will provide a key enabler for the asset visibility support to our warfighters."

F. INDUSTRY DRIVER

When Wal-Mart gets behind something, it's taken very seriously. For example, in the early 1980s Wal-Mart posted a large reproduction of a barcode in its vendor reception area. Underneath it was a sign that read, "If your product doesn't have one of these, don't sit down". At that time, only a few companies were using barcodes in the supply chain. Once Wal-Mart pushed the technology, the rest of the industry followed. Within a few years, barcodes were common place (Murphy 2003).

RFID was patented in 1973 but wasn't endorsed by Wal-Mart until 2003. Wal-Mart jump-started the RFID industry with a mandate that its top 100 suppliers begin using RFID tags on shipments to their stores. Overnight, RFID was put on the fast track. Vendors want to please Wal-Mart, so even if they are not in the top 100 they are investing in this technology because they want to show they are ahead of the game (Vijayan 2003).

Wal-Mart has already said that it will extend the mandate to additional suppliers in 2006 and will quickly move to implement it in Europe and then in the rest of its overseas operations. "This is absolutely a global directive for Wal-Mart," said CIO Linda Dillman.

Wal-Mart's top suppliers ship from eight to ten billion cases a year to the retailer's stores, often through third-party companies. Once these cartons are

electronically tagged, intermediate providers also will want to install an RFID infrastructure, which will add to the momentum. Wal-Mart's competitors, who receive products from many of the same suppliers, are probably going to follow suit, if they want to stay competitive.

G. THE VALUE OF LOGISTICS INFORMATION

In an NPS MBA project titled, "The Value of Logistics Information to the Warfighter" (2004) Corrigan & Kielar analyzed the benefit of integrating RFID technology into the DOD supply chain. The project confirmed the existence of an inherent value in logistics information when used as a resource in supply chain management applications. It also identified the value of real time logistics information to the warfighter and what they are willing to pay for that information. The conclusion was reached that there would indeed be value added by the inclusion of RFID technology in the Supply Chain.

That project also discovered that the benefits received from the installation of a Navy-wide RFID system could be measured by the cost savings realized. Reductions were also identified in the areas of labor and parts consumption. Benefits that could not be quantified were seen as a result from access to more accurate information, which in turn allows for more informed decision making (Corrigan, Kielar 2004).

H. ADVANCED TECHNOLOGY ORDINANCE SURVEILLANCE (ATOS)

An analysis of the costs and benefits of the ATOS program was performed by faculty at NPS (Doerr et al, 2004). The ATOS program involved RFID and Micro-Electro-Mechanical System (MEMS) technology. The group discovered, as with any new technology, not all of the benefits received from an RFID system are easily quantifiable.

Savings were anticipated in various areas. Labor costs may be reduced as the requirements for physical count and investigating the causes of inaccuracy decreased. The theory was also that the cost of demilitarizing ordinance that has become too unreliable or volatile may be avoided by better tracking environmental conditions. This

paper was successful in showing that multi-attribute analysis can be used to value non-monetary aspects of technology (Doerr et al, 2004).

I. PUTTING VALUE TO THE INTANGIBLES

According to Kaplan, Discounted Cash Flow (DCF) and other analytical techniques are consistently misused when applied to strategic IT investments. In his 1986 article, Kaplan theorized that companies often use too high hurdle rates in DCF Analysis. This reduces the attractiveness of projects with cash-flows that come far in the future. His argument makes sense if companies can estimate the future cash flows of possible projects. It is also reasonable to assume that there is more uncertainty about cash-flows the further they are in the future. The use of high discount rates could be one way to compensate for this.

It also makes sense to discount intangible benefits, which may be difficult to quantify. However, there is no reason to value them at zero. Kaplan sees real value to the intangibles, since they are usually revenue enhancing rather than cost reducing.

While Kaplan's article is about Computer-Integrated Manufacturing (CIM) it is also relevant to RFID because it discusses how a company might value a real investment that provides uncertain and intangible benefits. Kaplan also says that the cost of not investing is a real cost because competitors that do invest will take the business and reduce your profits (Kaplan 1986).

While the literature reviewed in the last three subsections dealt with quantifying intangible benefits, we do not propose to do that in our study. Instead, we will focus on the enumeration of key intangible benefits which we believe are overlooked in DOD ROI analyses, and leave to future work the issue of how to formally incorporate those benefits into a BCA. We will now introduce intangible benefits as they relate to this study.

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III. INTANGIBLE BENEFITS

A. INTRODUCTION

In his article “Wired for Transformation”, CDR Steve McDonald states the end goal of technology initiatives in logistics is “end to end in-transit visibility for all material from vendor or depot, through any node, to any customer anywhere in the world, hands free receipting, inventory, real time financial take up, accountability of material, and a wealth of data at your fingertips.”(McDonald 2004)

While extensive Business Case Studies have been or are being done in the DOD, to our knowledge these cases do not address the intangible benefits of RFID. Traditionally, a Business Case Analysis is completed to determine the return on investment and since intangible benefits have no monetary value they are not included. Such intangible benefits include but are not limited to:

B. THE INTANGIBLES

1. Increased Worker Satisfaction

One of the key finding in the NAVSUP BCA was that although RFID allowed manpower savings, most of them were lost through reutilization (NAVSUP 2005). However, that finding ignores the affect of technology on satisfaction (and hence, retention). Automation removes some of the monotony from performing tasks such as receiving, allowing employees to be refocused on more complex issues. Womack tells of the improvements in labor capabilities when they went from a historical mass production mentality, to one of lean production (Womack 1990). The empowerment of the employee increased performance and employee ownership.

2. Real Time Information

It is hard to put a dollar value on the knowledge that can be gained from automation. Navy Supply Officer’s stated they would pay up to 2% of their Optar to have real time information on high priority requisitions, which equaled $11 a requisition (Corrigan, Kieler 2004). This is not only applicable to the supply chain managers but to

the Combatant Commanders as well. Real time, reliable information might enable better decision-making than that made with only limited and outdated information.

3. Resident Expertise in New Technology

Kaplan illustrates that companies who embraced automation in the late 70's were much better situated to take advantage of the micro-processor boom of the 80's. The focus point of most anti-RFID literature has to do with cost and maturity. As more companies have implemented RFID because of the Wal-Mart and DOD mandates, the technology has advanced and prices have started to fall. By embracing RFID, DOD has an opportunity to become a leader in the implementation and application of RFID (Kaplan 1986).

4. Increased Customer Confidence

A recent GAO study found that lack of confidence in the supply system contributed to reordering and stockpiling. In addition, internal customers may get increased confidence due to the physical attributes of RFID tags. They can be subjected to the elements, run over, wrote on with indelible marker and are still readable. The efficiencies gained from these attributes provide minimal monetary return, but have sizable confidence implications. (GAO 2005)

5. Unforeseen Opportunities

During a recent site visit to Tanimura & Antle, the world's largest producer of head lettuce, they discussed innovations that allowed increased return on investments. Wal-Mart wanted to use re-usable plastic containers for lettuce so they could just drop the case in a slot on the line. The innovation came when they discovered a passive RFID tag could be embedded into the plastic container and used for up to 50 cycles. This allowed a 50 cent tag to be allocated over 50 trips vice one resulting in a one cent per case charge. This exploitation results in innovations which make the technology more affordable.

6. Information System Consolidation

An interesting finding in the NAVSUP BCA was that the largest potential ROI came from re-engineering or replacing the legacy systems with a SAP Distributed Warehouse Management System (DWMS). This finding, added to with findings that

middleware is lacking, suggests investment in RFID would provide the opportunity to standardize supply systems.

In a presentation from Col. Mark Nixon at Headquarters Marine Corps, the lessons from Operation Iraqi Freedom II include the finding that RFID is a great tool, but without better system support it requires people to intervene with the information provided by the RFID (Nixon 2004).

7. Improved Quality Control

The automation of processes from the introduction of RFID can greatly reduce human input errors and lost data. After installing a passive RFID system at the FISC Norfolk Ocean Terminal, an increase in manifest accuracy and inventory accountability within the Terminal was seen. This was accomplished by mitigating the number of errors introduced into the process by manual and/or nominally automated procedures. In its final configuration, the process was also found to increase speed and efficiency of the cargo checking process (NAVSUP 2004). Avoiding errors can also be correlated to less waste and more production from the workforce (Karali 2004).

C. CONCLUSIONS

In an analysis of the barcode implementation, Haberman reports that the industry discounted “soft benefits” to reduce the risk that implementation would be blocked. This action resulted in the “use of POS data for automatic reorder, shrink control, and inventory reduction…being ignored by the grocery industry for almost 20 years.” (Haberman 1999).

The so called “soft benefits” have been identified in this chapter as intangible benefits. The benefits of RFID and the other new technologies align themselves with the end goal of technology initiatives as presented in the opening paragraph by CDR MacDonald. While they are not captured by ROI, they present some unique opportunities to help achieve the desired end state in the DOD logistics train.

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IV. METHODOLOGY

A. INTRODUCTION

We determined that the most effective method to gather the needed information to properly answer the research question of our study was to assemble a written survey. Personal interviews were considered but since this paper lacked a sponsor it was not cost effective. It was determined that the least obtrusive method of gathering the information would be to conduct a combined email and telephone survey of a small sample of subject matter experts.

B. THE PARTICIPANTS

Finding personnel within the Navy who have experience with implementing the new technologies provides a limited pool from which to survey. The advantage of this pool, however is that they are very experienced. We chose to survey 15 authors of the NAVSUP BCA. The participants, who were provided in the report, had personal experience with a variety of the technologies in which we were interested.

The overall findings of the NAVSUP analysis was that the technology was not mature enough for full implementation. While a few of the initiatives have been adopted, many that were not had good lessons learned. It was the idea that they had all gained some value from the technology that suggested that this sample would be excellent candidates to tell us about the benefits and costs of RFID.

C. DATA COLLECTION

Data collection was completed by the researchers calling the participants and then giving them the survey. We chose 15 initiatives to survey; the participants were Officers, Chief Petty Officers and civilians. Seven surveys were returned, for a return rate of 47%, and used for data analysis. The researchers sent follow up emails and phone calls to attempt to increase the return rate, but finally only seven responses were collected.

D. DATA COLLECTED

The intention of the data collection was to provide a choice of benefits received by the participants in the initiatives. The data was broken down into five different sections which came from the literature review or the BCA results. In addition to capturing benefits, we desired to see if we could identify what drove the benefits. For this purpose we had the participants answer questions about the application they employed and which technologies they tried. We also asked them to identify any other technologies considered. We will now review the results of the survey.

V. FINDINGS

This chapter reviews the responses received from the survey. Chapter VII contains a more extensive analysis of the data. The responses were collected and consolidated using a Microsoft Excel spreadsheet.

A. PRELIMINARY DATA

Question 1. What was the focus or goal of your initiative? Choose all that apply.

a. Warehouse Management (Inventory Control and Identification)

b. Supply Chain Management

c. Parts Tracking

d. Other

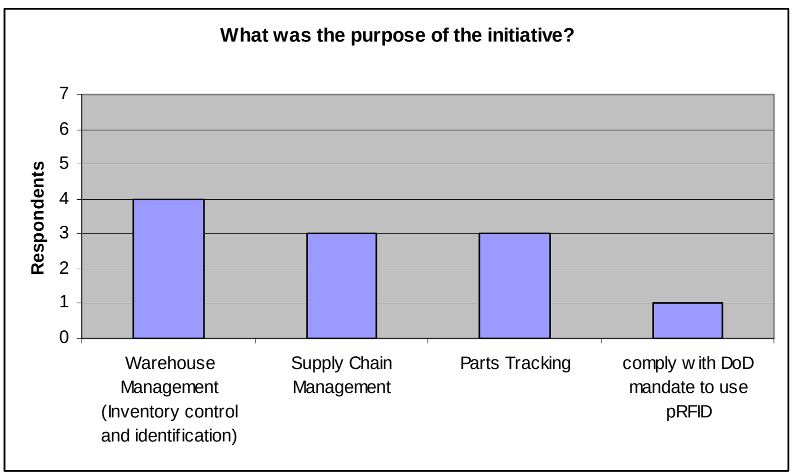

Figure 4. What was the purpose

This question asked the respondent to identify the purpose of pursuing a technological answer. While the respondents were given four options from which to choose, only one respondent chose all four answers. One other respondent had two purposes for different parts of the operation.

Question 2. Which technology are you involved in? Choose all that apply.

a. Active RFID

b. Passive RFID

c. Linear Barcode

d. 2D Barcode

e. Info-dot

f. Contact Memory Button (CMB)

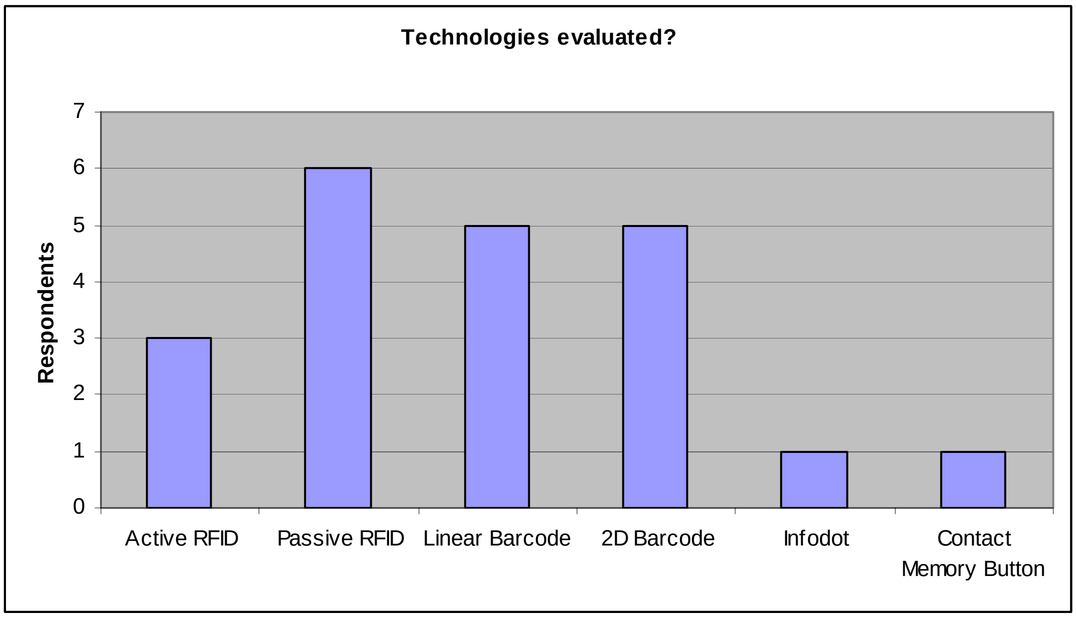

Figure 5. Which technology was evaluated

Question Two asks about the technologies being evaluated in their initiative. All the respondents had evaluated more than one technology, with three technologies being evaluated by five or more respondents.

Question 3. What is the status of your initiative?

a. Not complete

b. Implemented

c. Not Implemented

d. Submitted for further evaluation

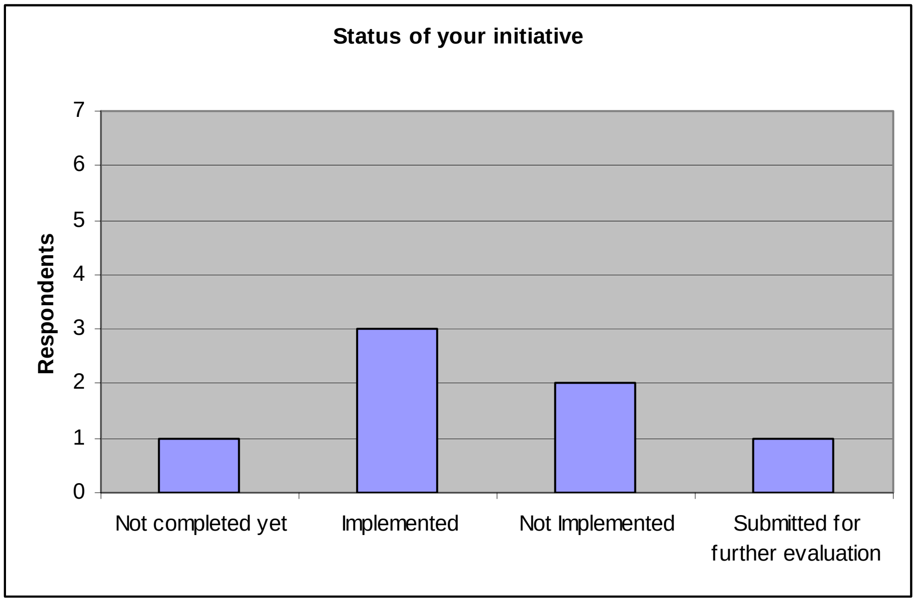

Figure 6. Initiative Status

Question 4. Were any other technologies considered for this initiative?

a. No

b. Yes

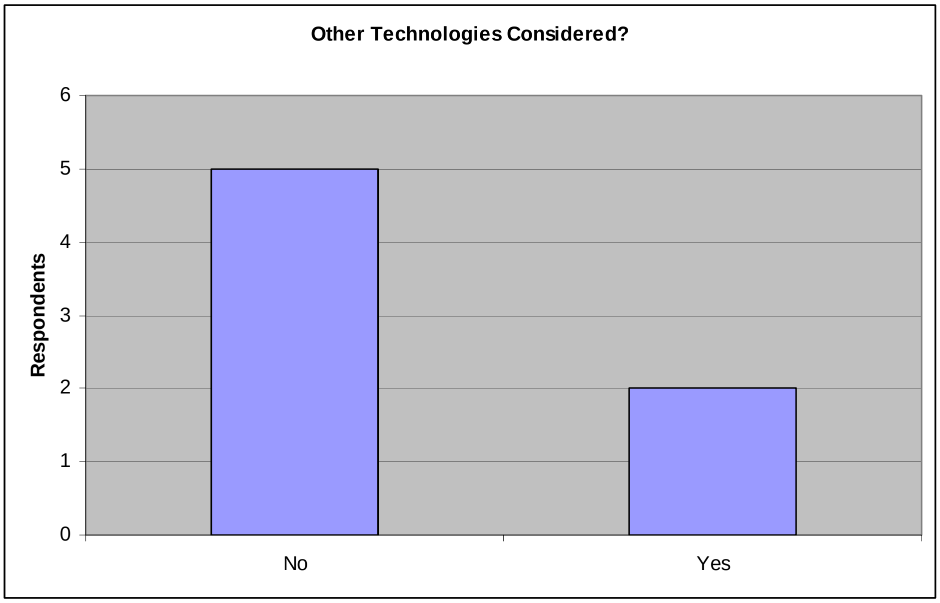

Figure 7. Were other technologies considered?

B. SPECIFIC BENEFITS

Question 5. In each of the following sections please identify which benefits, if any, that you received from your initiative. After you have identified your benefits please rank them in order of importance to you with one being the most important.

The sections chosen for evaluation were based on a combination of the intangible benefits found in the literature review discussed in Chapter II and the reports found in the NAVSUP BCA. We aimed only to evaluate that benefits were perceived by the participants with no regard to cost. In the analysis we will correlate the benefits with the application and technologies to determine the most beneficial applications. In sorting the responses many respondents failed to rank the precedent of the benefits so all benefits were ranked equally in our analysis.

1. Process Improvement

Under the process improvement section respondents were asked whether they received the following benefits. They were able to pick all benefits they experienced.

a. Decreased Complexity of Operations

b. Increased Ease of Inventories

c. Increased Accuracy of inventories

d. Increased speed of inventories

e. Other (write in)

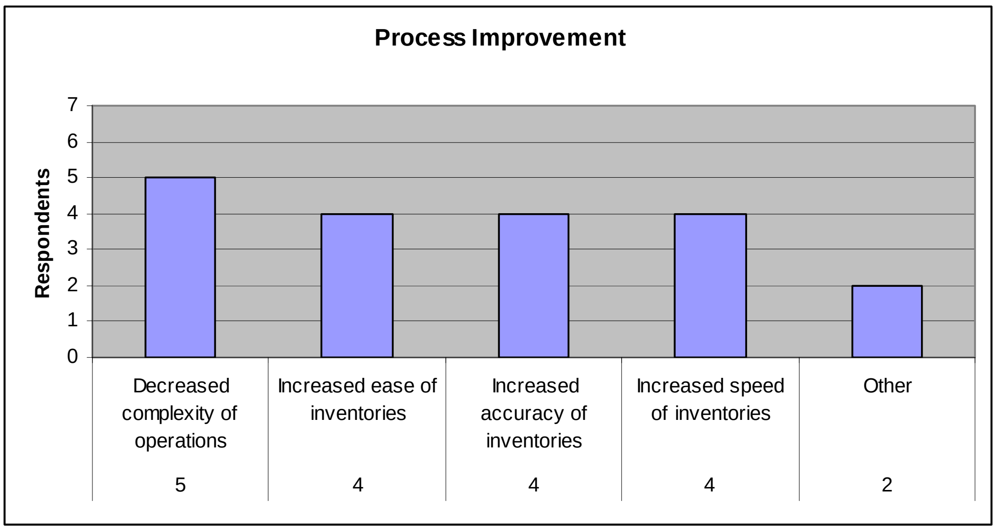

Figure 8. Process Improvement Reported

The process improvement section was based on evaluating the hype surrounding all of the new technologies. Advertisements for Passive RFID are full of claims to increase speed, ease and accuracy of inventories. This section was aimed at evaluating the perceptions of the users in the improvements gained from all the technologies. With 19 claimed benefits, the median user gained three benefits.

2. Supply System Information

Under the supply system information section respondents were asked whether they received the following benefits. They were able to pick all benefits they experienced.

a. Increased visibility (requisition, shipment)

b. Increased timeliness of information

c. Increased availability of information

d. Other (write in)

One respondent chose other, increased accuracy of information input to AIS was his response and is annotated in Figure nine.

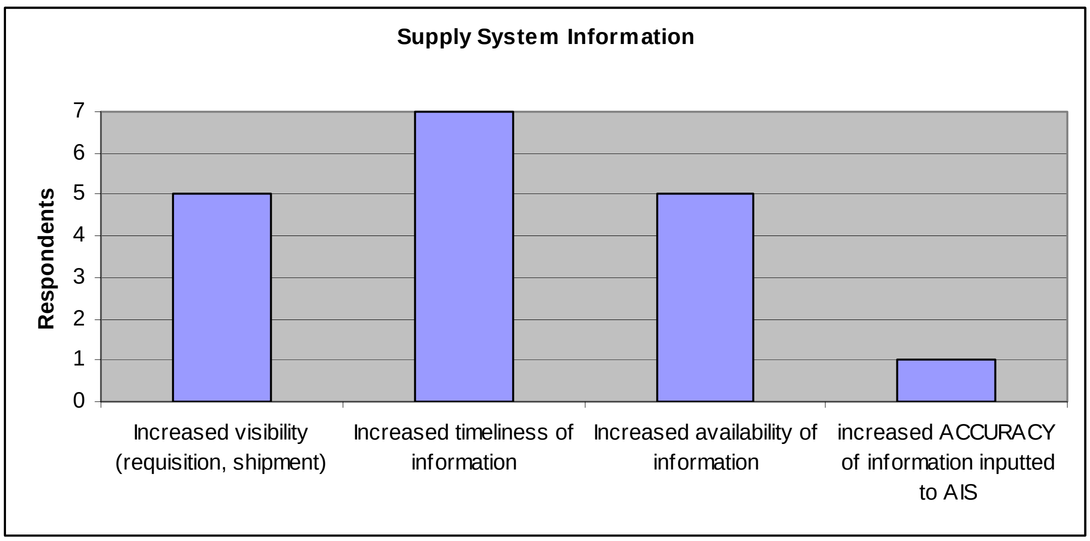

Figure 9. Supply System Information Reported

This section was completed to evaluate the perceptions of the user as to the value of information in the supply chain from the use of technology. With a total of 18 claimed benefits, the median user gained all three benefits queried.

3. Manpower Benefits

Under the manpower benefits section respondents were asked whether they received the following benefits. They were able to pick all benefits they experienced.

a. Increased worker productivity

b. Increased worker satisfaction

c. Increased worker utilization

d. Other (write in)

Only one respondent checked the other block, his response to reduce physical labor has been annotated in Figure 10.

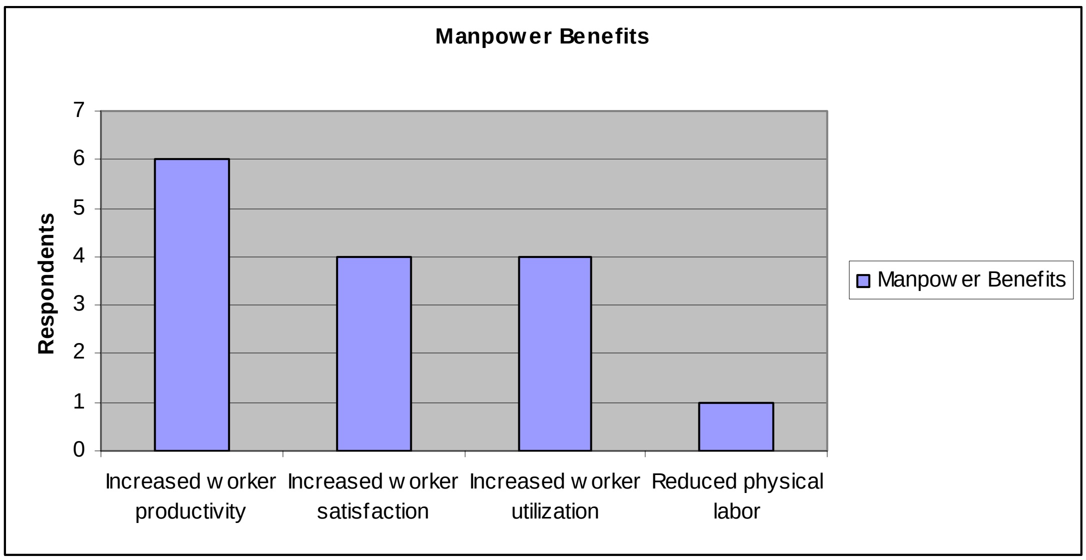

Figure 10. Manpower Benefits Reported

Much of the return on investment claimed by DOD in their estimates comes from Manpower savings. Two authors in the intangible benefits section remarked on different aspects of manpower savings. Since manpower is most likely flexed rather than released within DOD, manpower benefits are an important aspect of evaluating implementation of AIT. With a total of 15 benefits received the median user claimed two benefits.

4. Parts Information

Under the parts information section respondents were asked whether they received the following benefits. They were able to pick all benefits they experienced.

a. Increased amount of information available

b. Increased ease of part identification

c. Increased ease of locating parts

d. Other

Two respondents checked the other box and their responses have been annotated in Figure 11.

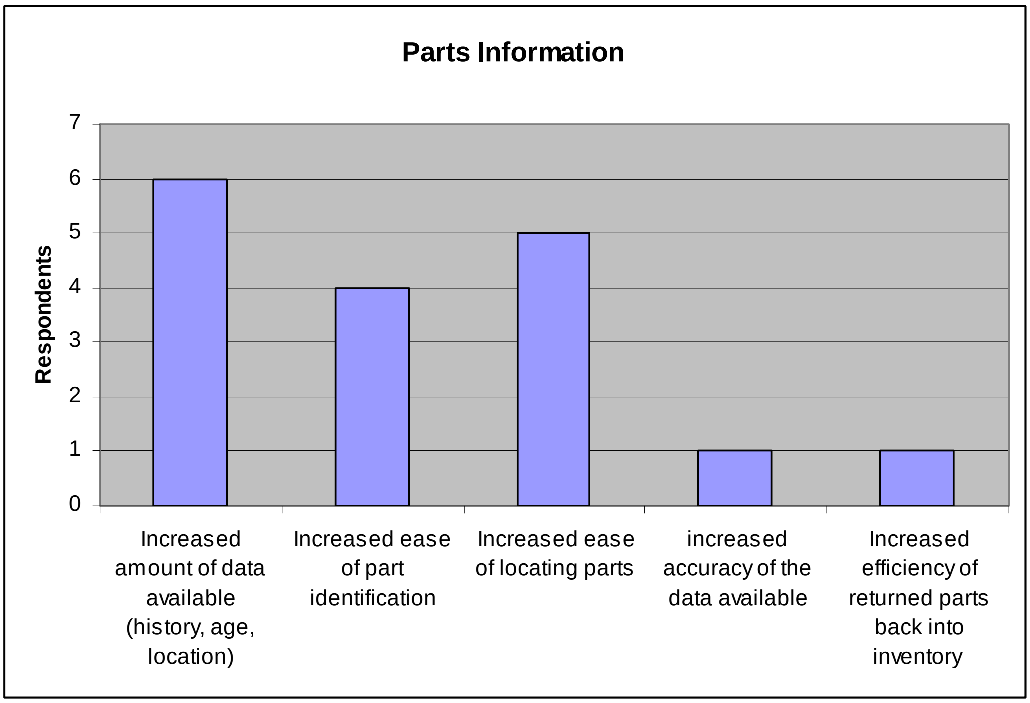

Figure 11. Parts Information Reported

All of the technologies are advertised as increasing the amount of information available with a read of the tag; each technology has a different application in mind. With 17 benefits claimed, the median user claimed all three benefits listed.

5. Customer Service

Under the customer service section respondents were asked whether they received the following benefits. They were able to pick all benefits they experienced.

a. Increase customer confidence in the system

b. Increased satisfaction

c. Increased knowledge

d. Other

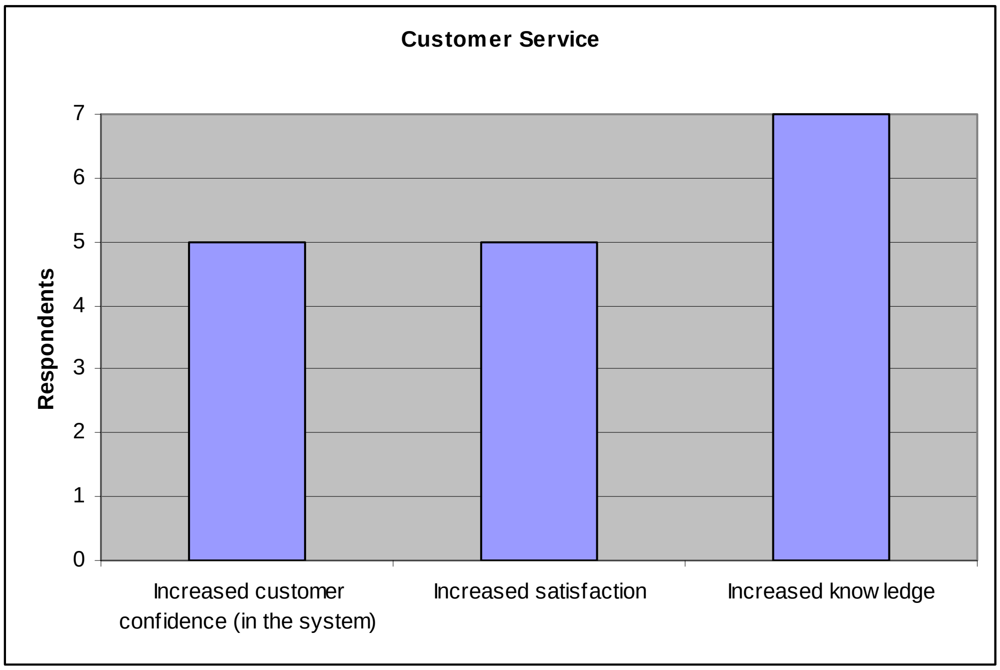

Figure 12. Customer Service Reported

Fleet readiness is the driving force behind most initiatives in the Navy. From the perspective of the respondents we wanted to get an idea of their customers satisfaction with the benefits derived from the new technology. As Supply Officer's we are familiar with the lack of confidence in the supply system as found in the GAO Report (2005), we wanted to see how the technologies impacted the perceptions from the fleet. With 17 benefits claimed, the median user claimed all three benefits listed.

Question 6. Now that you have identified areas in which you saw some benefit, please rank the area's importance with one being the highest.

a. Process Improvement

b. Supply System Information

c. Manpower Benefits

d. Parts Information

e. Customer service

Question six was designed to capture the benefit most valued by the participants. The data will be analyzed in the next subsection to discern where benefits are derived from, technologies or applications.

The raw data that was collected showed that the overall benefit received was extremely variable. The participants' responses are presented in the following table. The digits in the columns represent the number of each ranking that the category received.

# of	Process Improvement	Supply System Information	Manpower Benefits	Parts Information	Customer Service
1's	2	3	1	0	1
2's	1	1	2	2	1
3's	1	2	1	2	1
4's	2	1	0	2	2
5's	1	0	3	1	2
Total	7	7	7	7	7

Table 1. Raw Benefits Results

Rank medians are as follows:

Supply System Information: 2,

Process Improvement: 3,

Manpower Benefits: 3,

Parts Information; 3,

Customer Service 4.

In terms of average ranks then, the largest benefit came from Supply System Information, then Process Improvement, Parts Information, Manpower benefits, and lastly Customer Service. This finding though not statistically supported would suggest that technology does increase visibility, availability of information, and timeliness of information.

Next, we look at the data in relation to the technologies and the applications from which they were obtained. We will examine the relationships between the benefits and their application.

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VI. ATTRIBUTES CONTRIBUTING TO SYSTEM PERFORMANCE

A. EXPLORING VARIABILITY

The premise behind this chapter lies in the idea that technologies have attributes and applications require functions. When there is a match between the attributes of the technology, the functions required for an application and the environmental factors, this should result in a successful initiative.

In collecting the data in Chapter V, we had anticipated that benefits would exist but that they would follow either the technology or the application. In looking at the data we came up with the idea that benefits depend on a multitude of other things as well. This chapter will examine RFID in terms of attributes that contribute to performance. We feel that the attributes of a new technology application can contribute or detract from benefits derived.

This idea was originally spawned when we read Figure 13, in the NAVSUP BCA (NAVSUP 2004). As you can see the read rates of passive RFID were not consistent across all applications. They ranged from a high of 99% in warehouses, to a low of 38% in the Air Force shipping label demo. Since the benefits we were interested in were based on increases in speed, information and accuracy, it seemed like the volatility of the read rate would undermine our findings.

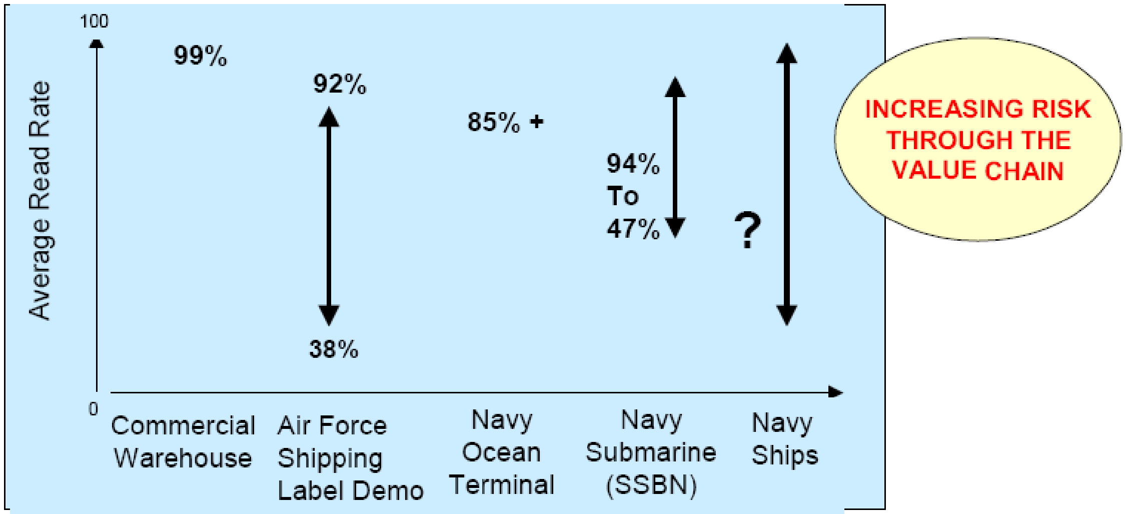

Figure 13. NAVSUP Read Rate Ranges

With this in mind we sought a framework from which to examine the variability of the technology. We ended up with Figure 14, which is one perspective of assessing the factors that define system performance. Since the read rates were addressed in the technical performance and we could see a relationship with the rest of the areas, this is how we decided to approach finding the answer to our question.

B. AN OPERATIONS APPROACH TO SYSTEM PERFORMANCE

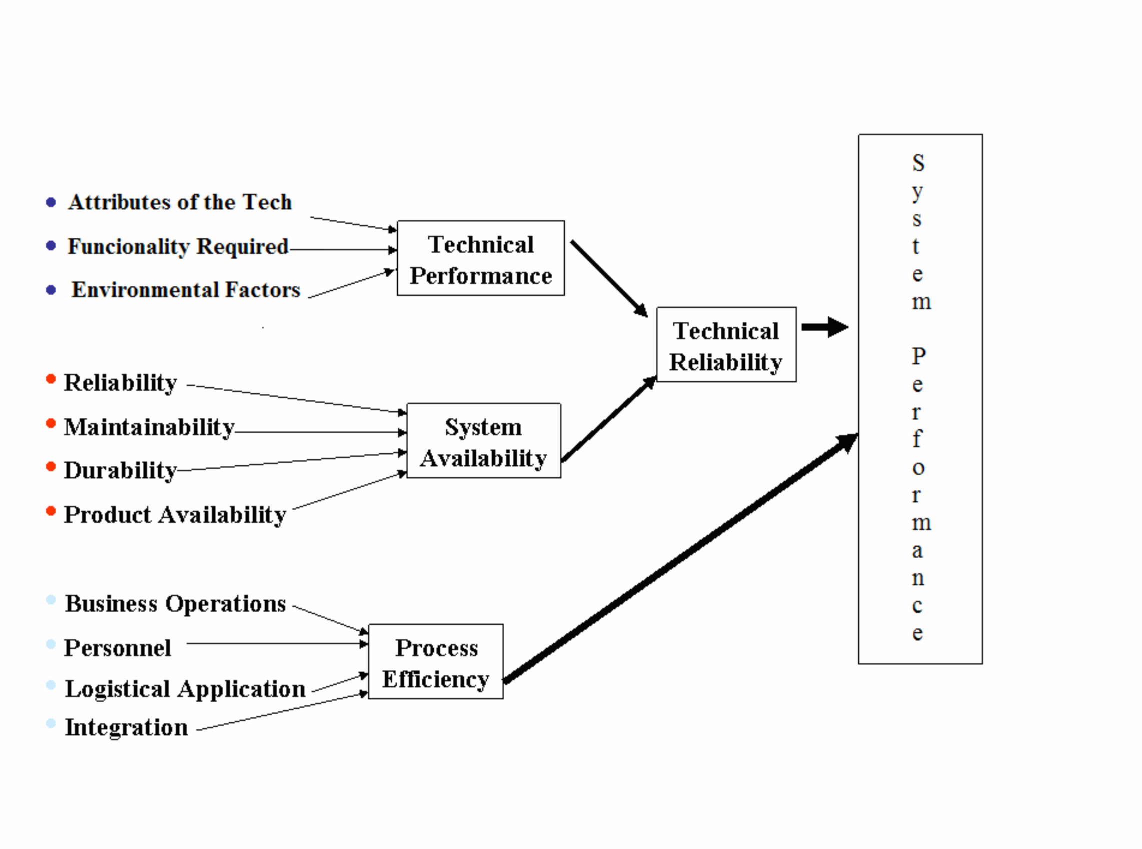

Figure 14. System Performance from an Ops Management View

Using this model to lead the discussion, this chapter will focus primarily on the attributes that define the overall system performance attributes of Passive RFID. Where it is germane, we will discuss the other technologies as well.

C. TECHNICAL PERFORMANCE

Technical performance is an important consideration when seeking benefits from the introduction of a new technology. All of the initiatives seek to improve the performance of their systems by introducing new technologies. The technical performance of the system will directly affect not only the benefits received but also the perceptions of those using the system in terms of the value of the technology. Poor technical performance will create an adversarial attitude toward the new technology and will minimize the possibility of recognizing benefits that occur.

1. Attributes of the Technology

Bar Code Tags	RFID Tags
Bar codes require line of sight to be read.	RFID tags can be read or updated without line of sight.
Bar codes can only be read individually.	Multiple RFID tags can be read simultaneously.
Bar codes cannot be read if they become dirty or damaged.	RFID tags are able to cope with harsh and dirty environments.
Bar codes must be visible to be logged.	RFID tags are ultra thin and can be printed on a label, and they can be read even when concealed within an item.
Bar codes can only identify the type of item.	RFID tags can identify a specific item.
Bar code information cannot be updated.	Electronic information can be overwritten repeatedly on RFID tags.
Bar codes must be manually tracked for item identification, making human error an issue.	RFID tags can be automatically tracked, eliminating human error.

Figure 15. Attributes: Bar Code versus RFID, (Wyld 2005)

In considering the adoption of RFID, what are the desired attributes that make RFID so attractive over bar coding? To start with, the read range, read speed and true machine readability are the most relevant attributes that are sought by those transitioning to RFID. The attributes of the technology can increase the capabilities of the user.

For example, if receiving functions can be automated by sending pallets through RFID readers which can automatically inventory the pallet, then the timeliness and accuracy of the receiving function could be greatly improved.

In the same sense, the ability to monitor the location and condition of shipping containers throughout the supply chain could greatly increase visibility and accountability providing decision makers with the information required to make more timely and informed decisions about the supply chain.

The ability to update read-write tags, gives them many useful applications. In the supply chain updating the expiration dates of materials would be extremely useful and efficient. There are many applications from spare parts to controlled substances and pharmaceuticals that could take advantage of this attribute.

The long life span of tags increases the likelihood of allocating the cost of the tag over numerous uses. During a recent visit to Tanimura &Antle, the self proclaimed world's largest producer of head lettuce, the company reported Wal-Mart was using reusable plastic containers (RPC) for head lettuce with an embedded passive tag. The cost of the tag was $.50, but it was scheduled to be reused at least 50 times. This would allow the cost of the tag to be amortized over 50 applications instead of one. This sort of application holds the future of RFID implementation.

The author of "RFID for Dummies" states that when adopting RFID technology there is a choice to be made between the available attributes of speed, range and accuracy. The author stipulates you can have any two of the three but it is not possible to gain all three. This introduces the idea that technology, is not able to answer all needs, but rather provide options based on a choice of variables (Sweeney 2005).

2. Functionality Required

As we identified in the previous section, the application or function that the technology will be used for is as important to choosing the technology as the attributes of the technology.

Linear barcodes and 2D barcodes have attributes that fulfill a function in the retail industry today. The function required is interoperability; the key attribute of barcodes is

that they are a universally accepted standard. They have the advantage of being well established and are extremely low priced. While many companies are seeking to identify the advantages of implementing RFID, all recognize the need to keep the established barcode system in place.

2D barcodes are relatively new and are available as a microdot which is extremely small and can carry large amounts of information. This requires hands on scanning similar to a barcode. They are most functional at managing piece level data. They provide a lot of potential in the area of maintenance records and maintaining accountability on unidentifiable repair parts.

The primary attribute of the three flavors of RFID is passive reading. They are used when users want to eliminate touching the parts to find out what they are. They are primarily used in inventory control and supply chain management. The systems utilize radio frequencies which limit them from being used in some applications.

Passive tags, having the shortest read ranges and no separate power source are most useful for access badges, mass transit passes and item level management in the supply chain. Most of the Wal-Mart initiatives have dealt with passive RFID. They have explored the use of door readers, forklift readers and hand held readers. Wal-Mart has experienced the most problems reading palletized individual boxes. Their lessons learned in this area are helping to create new business processes which allow the function to utilize the capabilities. By ensuring the tags all face externally and there are no boxes hidden in the middle they are able to overcome this challenge.

To this point in time active tags have been primarily utilized for tracking shipping containers and high dollar, highly pilferable items. The capabilities of the active tags are offset by the high cost of the tags. In looking at the function of active tags, it is important to recognize that they possess the most capabilities and if not for the dollar value of the tag could realize the most benefit of the technologies available. The autonomy of active tags to identify what and where it is makes the idea of automatic warehouse management and supply chain management possible. If DOD desires an increase in these areas the best answer may in the end be active tags. The offset to the high cost of the tag would be

the relatively low cost of the infrastructure to read the tags. The economies of scale from such a commitment could also help to lower the costs and advance the maturity of the technology.

3. Environmental Factors

Frequency Band	System Characteristics	Example Applications
Low (LF) 100–500 KHz (typically 125–134 KHz worldwide)	• Short read range (to 18 inches) • Low reading speed • Relatively inexpensive • Can read through liquids • Works well near metal	• Access control • Animal identification • Beer keg tracking • Inventory control • Automobile key/anti-theft systems
High (HF) (typically 13.56 MHz)	• 13.56 MHz frequency accepted worldwide • Short to medium read range (3–10 feet) • Medium reading speed • Can read through liquids/works well in moist environment • Does not work well near metal • Moderate expense	• Access control • Smart cards • Electronic article surveillance • Library book tracking • Pallet/container tracking • Airline baggage tracking • Apparel/laundry item tracking
Ultra High (UHF) 400–1,000 MHz (typically 850–950 MHz)	• Long read range (10–30 feet) • High reading speed • Reduced likelihood of signal collision • Difficulty reading through liquids • Does not work well in moist environments • Experiences interference from metals • Relatively expensive	• Item management • Supply chain management
Microwave 2.4–6.0 GHz (typically 2.45 or 5.8 GHz)	• Medium read range (10+ feet) • Similar characteristics to UHF tags, but with faster read rates	• Railroad car monitoring • Toll collection systems

Figure 16. RFID Operating Frequencies, Wyld (2005)

Figure 16 is provided to show the different frequency ranges in which RFID operates. The wide spectrum of available frequencies is the key to understanding the environmental consideration in choosing the technologies. Each range has specific advantages as well as disadvantages to its use given whatever environmental factors are in play in a particular location. In addition to the limitations of the transmission range, environmental issues can include such things as mud, snow, altitude, rough handling, and repackaging. In the end the overall functionality of the tag depends on the application, the technology chosen and the ability to capture potential capabilities.

The choice of radio frequency is a consideration of the environment in which the chosen technology will operate. There are four main frequencies, identified in table 3 which we will discuss.

The low frequency tags operate at the Kilohertz (KHz) level. This is most suitable for very short range readers. This would be similar to the read range of a barcode reader. Some examples include livestock tagging, antitheft systems and key lock systems.

The high frequency tags operate at the low Megahertz (MHz) level. According to one interview this is the most stable of the RFID technologies. It has a shorter read range than the ultra high frequencies, about three to ten feet. The shorter range allows increased reliability in the read rate. Conveyer belt operations could maximize use of this range, as well as pallet level tracking (Second round interview).

The ultrahigh frequency levels, which is what most of the current studies are utilizing, operates in the 900 MHz range. These tags can be read from ten to thirty feet, but at this distance the tags are much more susceptible to environmental interferences. It has a high read rate, from 100 to 1000 tags per second, but the reliability of the reads has not been established. Since this frequency is subject to interference it has an increase in false reads, as compared to the lower frequencies. The most common applications are supply chain management, shipping containers, pallets and tractor trailers.

Tags in the Microwave range of two to six Gigahertz (GHz) are the most susceptible to environmental interference. These tags have a read range of approximately ten feet and other characteristics similar to the UHF tags. With a higher read rate than the UHF tags, these tags are mainly used for railroad car monitoring and toll collection systems.

The lower the frequency the more likely it is to pass through impediments such as boxes or snow. High heat and humidity makes higher frequencies less reliable. The examination of the external environment is key to choosing the right application.

D. SYSTEM AVAILABILITY

1. Reliability

The definition of reliability is the probability that the item will perform a specified function under specified operational and environmental conditions, at and throughout a specified time (Kales 1998). A system with poor reliability poses much

more potential risk than one that has high reliability. When introducing a new technology, risk management must be completed to assess the risk associated with the reliability.

Figure 13 from NAVSUP shows how variable read rates can be and how these rates are used to support or in this case take away support from RFID initiatives. In the report, each case is documented in-detail to document how variability affected performance and was directly related to the overall experience. It should also be noted that even the NAVSUP case study shows that the commercial warehouse where variability is limited possesses a very high read rate, in this case 99%. This lack of variability in a standard warehouse is what makes RFID so attractive to Wal-Mart. The lack of variability allows Wal-Mart to systematically eliminate the remaining sources of variability.

In looking at the web sites of many RFID vendors, RFID is sold to companies to increase speed, range and accuracy of the data collection. The retailers market the technology as one size fits all. How can they make this claim when RFID is sensitive to so many variables? The variables which have the most impact on RFID performance have to do with the physics of radio wave transmissions. Radio waves do not pass through metals or liquids. Higher frequencies can go longer distances but are more susceptible to interference than lower frequencies. The speed that the object passes the reader affects the read accuracy. The isolation of the reader from tags outside the scope of interest is the key to preventing excess unwanted information.

In the end the reliability of RFID depends on how well the application of the technology fits within the capability limitations of the technology. Each implementation must be handled as a unique project, taking into account inherent reliability, environmental considerations and the physical limitation of radio waves. In looking at the performance of read rates in Figure 16, the submarine read rate variability could have been predicted given the environment in which they operate

2. Maintainability

The National Institute for Occupational Safety and Health qualitatively defines maintainability of equipment as a designed-in characteristic that imparts to a machine an inherent ability to be maintained with reduced person-hours and skill levels, fewer tools and support equipment, and reduced safety risks. How easy and cost effective is it to repair the system when a problem does arise? This is especially important when adopting new technologies because you have no resident experts. Another problem associated with maintainability comes from a lack of standards. The risks associated with low maintainability must also be assessed prior to adopting new technologies.

Maintainability of the RFID systems is based on the maintainability of the parts and pieces of the system. RFID systems are composed primarily of tags, readers, antenna, and a database. In our experience, new applications for technologies are generally cutting edge and are aimed at seeking capability and performance with maintainability as an afterthought. Since passive tags are reusable it is important that they are designed with maintainability in mind. In a recent visit to California Poly-technical University, we noted that the passive tags were as simple as a paper tag with an embedded chip and antenna making maintenance highly unlikely. Active chips seemed to be much better candidates for maintenance.

3. Durability

A key aspect for any new technology is durability. Can the parts withstand the rigors of the operations in which they will be used? The environments that the military operate in can be significantly different from the private counterparts. A civilian company will tag materials, load them on a truck and ship it to the local distribution center 10 miles away. The DOD parts may go on a truck, a boat, a plane and a camel; the possibilities are unlimited. Any technology that is to be adopted by DOD must have proven durability.

There are three major components to any RFID system: the tag, the reader and the antennas. The tags are durable but do have documented (Informationweek 2004) problems with reliability from the warehouse. The literature shows that approximately

20% of the tags do not work when coming from the printer, the problem being the connection between the chip and the antenna. That being said it follows that the durability of that connection is circumspect.

The readers are also sensitive to changes in environmental conditions, specifically to electronic interference, and are not built for the rigors of constant moving. The durability of the readers will be an area of concern when considering implementation of an RFID system. In a warehouse that is designed for RFID, these problems could be mitigated by the fact that the warehouse is stationary. When implementing RFID into an existing warehouse, electronic interference must be evaluated prior to implementing RFID.

4. Product Availability

Is the technology currently available from numerous vendors or is the supply limited? This question should be answered prior to adopting any new technologies. In 2004, Information Week reported many vendors being backordered up to 12 weeks due to the rapid buildup from the Wal-Mart initiative. This lack of available product seriously undermines the ability to implement a technology initiative.

In the area of RIFD there are many companies creating new applications on a daily basis, for example the DOD mandate directed one application of RFID, while NAVSUP ended up with 28 niche application initiatives. No one company has established itself as the Microsoft of the RFID industry. While DOD has contracts to fulfill their current obligations, they could change vendors to the industry leader if one comes available. If this holds true across DOD and civilian industries as well, availability could be limited for the start up period. Within DOD an order of need would be established, whether first come first serve or based on priority, the material would not be available to all who wanted it. In conversations with Tom Bruno of Bruno and Associates, he stated they needed to complete testing on passive RFID systems, but the materials were not available and had a significant leaf time.

E. TECHNICAL RELIABILITY

Examination of all of the inputs to this point should give a pretty good picture of the overall technical reliability. There are however some areas of concern that should be addressed if an RFID system implementation is planned.

1. Technical Reliability

Technical reliability will depend on the identification of projects that have the highest likelihood for success. This was documented in the NAVSUP BCA by identifying projects where an early ROI was likely. The most interesting case is the Aviation Pack Up Kits (PUK). The PUK containers were configured for RFID and built to specifications which would support the technology. The visibility of inventory was dramatically improved while significantly reducing the inventory time. A recurring theme presented itself while talking to CDR Gamboa, who spearheaded the project. When asked how the deployment of the PUK worked, CDR Gamboa stated that the first time it was deployed it worked excellent. When the unit conducted a turnover of the PUK, the results were more in line with pre RFID experience. The difference in the two results was attributed to sending an E-4 who was an advocate to conduct training on the initial deployment. The E-4 was not sent out when the units turned over. Training and experience are keys to the success of RFID.

2. Choosing the Right Technology

The correct technology match needs to be made. The physics of radio waves and their restrictions make shipboard applications improbable in the near future. An interesting approach identified by the NAVSUP BCA was to put sensors on the pier that could receive the materials as they are delivered to the ships. This seems to be the most realistic approach to shipboard inventory control using RFID; however there are variables that must be addressed. One manufacturer's tags may not be read by another manufacturer's readers. Standards will have to be set. Shipboard stores vary from paper and cardboard to metal boxes and engines. While each type of material can be worked around, this increases the level of knowledge required by the end user of the technology. Standards would alleviate this problem.

F. PROCESS EFFICIENCY

1. Business Operations

Business operations are another key element to the success or failure of RFID implementation. The Wal-Mart initiative has been well documented. The first phase of their initiative established one distribution center that would use RFID to work out the bugs and develop the business practices. Since all distribution centers are essentially the same, this approach should give Wal-Mart a high probability of success.

DOD intended to initiate RFID based on one application, Inventory Control Points. When the Navy examined its warehouses it found the potential for Return on Investment slim due to the small warehouses with limited access points. The Navy then went on to do a number of initiatives that examined niches. Each initiative was started on its own, adopting its own processes and policies.

In the case of Norfolk Ocean Terminal (NAVSUP 2005), they found that "tagging cannot be wedged into existing barcode processes. The business process' will need to be studied and redesigned from scrap." This is part of the loss of efficiency that DOD will experience much more than Wal-Mart. Since Wal-Mart is starting with one scenario and making the processes they should be able to achieve more consistent performance in their applications.

2. Personnel

As previously discussed the training of personnel to operate the system, fix the hardware and the software and manage the data should be preplanned to ensure success. We do not think these skills should be added into an existing rating such as IT or SK, thinking RFID is going to be a fulltime job until the technology reaches maturation. The skill sets required of personnel working in Supply is much lower than that of the more technical rating, supply personnel are not selected based on technical competence or potential competence. The IT personnel are already challenged with the communication systems, the LAN and all computer upkeep.

The NAVSUP BCA showed a direct correlation between training level and performance of RFID. That being said resident experts will need to be available to introduce RFID on a widespread basis.

3. Logistical Application

Defining the application that RFID will be used for within the logistics arena increases the possibility for success. The DOD initiative mandates tagging materials with no specific application in mind. The DOD BCA envisions a world where all Inventory control points are RFID equipped and savings come from minimizing lost materials. This requires one specific type of application which would call for standardized tags, with standardized readers and support equipment at all DOD supply activities.

The NAVSUP BCA argues that due to the limited access points on Navy warehouses RFID does not have significant value over existing methods. It would present the most value in places where barcodes are not already in place. Due to the limited size and the limited number of items coming from DLA and vendors (tagged materials), the value of implementing RFID does not exist. While they were unable to substantiate value for implementing RFID in a manner consistent with the DOD mandate, they do see the potential value in other applications. By applying the technology to numerous initiatives, the Navy seems to be seeking the right combination of application and value to determine where to fit this new technology.

While DOD predicts a three year breakeven in the worst case scenario, NAVSUP calculated a three year ROI in the best case. These breakeven values are based on the Inventory Control Point application. These different approaches have significance in the affects on RFID as well. The DOD scenario applies the technology to one application. This would allow for maturation of the technology, business processes, as well as cost benefits from economies of scale. The NAVSUP approach will expand the application and potentially the capabilities of RFID.

4. Integration

Integration is the ability to incorporate technology into the existing infrastructure. As previously noted, the Norfolk Ocean Terminal initiative identified that RFID cannot

be implemented into existing barcode processes. It would follow that to integrate RFID into the existing infrastructure will require more structure than is currently being applied.

The performance parameters of the technology will improve as more companies get involved in developing the technology. The standardization of the technology is inevitable with the current initiatives from Wal-Mart and DOD. As previously discussed the logistics of implementing the system are as important to the success as the system itself. The training, maintenance, and business operations must be developed prior to the initiation of the technology.

G. SYSTEM PERFORMANCE

The overall system performance is the summary of the sections provided above. Things that are readily apparent when adopting a new technology is the risk associated with the technology. Implementing RFID requires a commitment to changing the practices to incorporate an unknown reliability, etc. All the areas identified above should be closely scrutinized to minimize the risk associated with such an endeavor.

This chapter has presented an outline of system performance. As we discussed in the previous chapters, all the participants received benefits in one form or another from the technologies used. In the next chapter we will discuss the data analysis that was performed on the answers

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VII. DATA ANALYSIS

A. WHAT CAN WE LEARN?

The system performance chapter outlined the idea that only by combining the right technology (particular attributes), the right application (desired functionality) and taking into account the environmental factors can we have a successful technology implementation. This chapter will look at each initiative in terms of fit against the benefits received to establish whether or not benefits can be derived. In the end can we answer what drives the benefits and can it be formulated to predict benefits for a new initiative?

Figure 17 provides an illustration of our respondents benefits derived with the outcome of the initiative. We will begin our analysis with the not implemented initiatives and end with the implemented initiative. The goal of this analysis is to attempt to identify the fit or lack there of which contributed to their outcome.

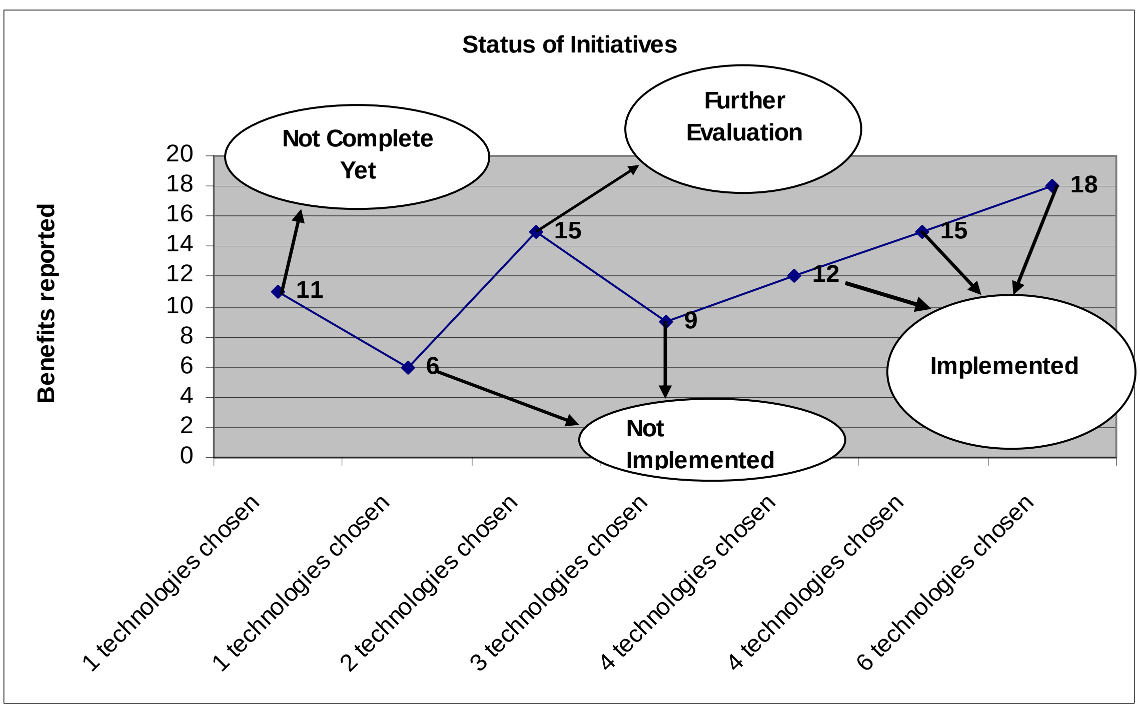

Figure 17. Status of Initiatives

B. THE INITIATIVES

To start this analysis we will start with the two initiatives that were not implemented.

1. Initiatives Not Implemented

The first initiative not implemented, which recognized a total of six benefits, was trying to implement Passive RFID to track circuit cards.

GOAL: The goal was to decrease down time on critical systems by increasing asset visibility of high priority repair parts onboard a submarine.

FIT: Passive RFID fits the goal of increasing asset visibility. It should be noted that these parts are small circuit cards kept in small modules, which would limit the ability for passive reading.

FUNCTION: The goal is consistent with the capabilities of the technology.

ENVIRONMENTAL ISSUES: A submarine has many things that will impact the performance of passive RFID. Space is extremely limited so an installed reader system would not be optimum. Most likely this initiative would require the use of hand held readers. The small spaces with lots of metal would provide much interference with the readers. There are numerous transmitters and the transmission restriction onboard submarines would not make Passive RFID an easy fit.

FINDINGS: The read rates experienced onboard a submarine, were unacceptable for meeting the submarine service inventory requirements of 100% accuracy. The tags were too big to fit in the modules and still be read.

OUR ANALYSIS: Of particular interest on this initiative was that no other technologies were considered. Our research suggests that 2d barcodes or Contact memory buttons would have provided a much better chance of success.

Of particular interest on this initiative's results is the fact that they were still able to recognize increased ease of inventories, timeliness of inventories, worker productivity and satisfaction, amount of data available and customer knowledge. These results are interesting because the write up made it sound like Passive RFID was a horrible fit.

These findings are consistent with the fact that the attributes of RFID were a good fit the functions required for this application.

The second initiative not implemented, which recognized a total of nine benefits, was trying to implement Passive RFID into a receipt system which was already utilizing linear barcodes and 2D barcodes. No detailed report was available.

GOAL: The goal was to seek improvements in visibility and accountability during shipping and receiving from material processing centers to ships.

FIT: Passive RFID fits this initiative if automated receiving and monitoring is the goal.

ENVIRONMENTAL ISSUES: There are many environmental issues at hand here. The stability of the electronic environment onboard a ship is poor. The ship constantly changes piers, headings and transmissions. To establish a stable, dependable system that takes into account the environmental issues would be very challenging.

FUNCTION: If the environmental issues can be addressed the technology is a good fit.

FINDINGS: Able to prove ability to read at the item, case and pallet level. While the respondent put not initiated, the Navy Supply Corps Newsletter from September 2005 showed that this initiative is still taking place onboard one ship. They were able to set up readers and make them work onboard a naval vessel.

OUR ANALYSIS: This initiative was only able to garner nine benefits out of a possible 20. This was the second lowest ranking we received. The lack of fit could have predicted the lower benefits derived.

Of particular interest was that the Process Improvement section (which deals with increased inventory performance) and the Manpower benefits (which deals with worker utilization) were the top two ranked sections for this respondent, which are consistent with expected benefits from automated reads. However they reported zero parts information benefit (which dealt with finding and identifying parts), which is not consistent with automated reads. If passive RFID was able to improve the process and

increase speed and accuracy of inventories, it is not consistent that zero parts information benefits would be received.

2. Submitted For Further Evaluation

One initiative was submitted for further evaluation, which realized 15 benefits. This initiative was to use passive RFID to improve accountability and visibility.

GOAL: The goal was to seek improvements in accountability and manage transfer of deployable Pack Up kits.

FIT: The fit of the technology was addressed during the design of the process. The initiative called for the creation of RFID friendly boxes with hand held scanners. Once the inventory was complete data was transmitted via satellite directly from the container. This innovation took advantage of the attributes of RFID while addressing the shortfalls of an unstable environment.

ENVIRONMENTAL ISSUES: Numerous issues were addressed in designing this initiative, illustrating how forward thinking can overcome constraints.

FUNCTION: The goal is consistent with the attributes of the technology.

FINDINGS: The initiative was able to realize significant manpower savings through incredible inventory time savings. They were able to successfully deploy. One finding of interest was during the first deployment savings were significant, when the time savings dropped during the turnover research showed that training had not been conducted resulting in less significant savings.

OUR ANALYSIS: This initiative realized all but one benefit offered. That benefit was increased worker satisfaction, which makes us consider the ability to grade that benefit.

This benefit supports our theory that understanding the variables involved and making the right fit will increase the return on investment and intangible benefits received.

3. Not Complete Yet

One initiative was returned as not complete yet, but as of this time has resulted in the receipt of 11 intangible benefits. This initiative was intended to utilize 2D barcode to improve receipt confirmation.

GOAL: The goal was to improve receipt process of international shipments to foreign countries. It utilized 2D barcodes with software coordination on both ends. In looking at the technology, it is interesting to find they considered passive RFID.

FIT: The fit of 2D barcodes for this goal is consistent with the technology. By sticking with a form of bar-coding instead of RFID, they were able to reduce hardware requirements on both ends.

ENVIRONMENTAL ISSUES: Due to the unlimited variability of locations, environmental variability would be significant. By choosing 2D barcodes they are able to minimize the impact of environmental issues.

FUNCTION: This function is consistent with the attributes of barcoding.

FINDINGS: The findings are that the initiative is moving forward and expects to be implemented. All hardware has been purchased and with annual losses in excess of 15 million dollars they predict a breakeven point in five years with a ROI of three to ten times the investment.

OUR ANALYSIS: The technology fits the application. Working with other countries increases the complexity of this situation and by choosing to use a beefed up barcode, they have increased the likelihood of success.

They have been able to recognize all benefits in the areas of Supply system information, parts information and customer service which is consistent with having the right fit.

4. Implemented

The first initiative that was implemented realized 12 benefits by using active RFID, passive RFID, linear and 2D barcodes.

GOAL: The goal of this initiative was to increase manifest accuracy and improve material handling efficiencies at an outgoing ocean terminal.

FIT: The choice of technologies was an important consideration given the variability of the materials they are handling. The handle shipping containers and everything inside which resulted in the choice of numerous technologies.

FUNCTION: This function is consistent with the attributes of RFID.

ENVIRONMENTAL ISSUES: Since this is taking place in a stable warehouse the environmental issues may exist but are stable and can be addressed. By modeling the warehouse and measuring the environmental electronic transmission this initiative is able to overcome the impact of the issues.

FINDINGS: This initiative had some very pointed findings that illustrate some common areas of concern for all who want to implement new technology combinations.

- Tagging materials using different media requires testing to identify the best read spots.
- User training is a significant endeavor; users must learn the fundamentals of RF limitations
- Tagging with RFID cannot be wedged into existing business practices, practices must be studied and redesigned from scratch (NAVSUP 2004)

OUR ANALYSIS: The learning curve of adopting new technologies is a significant part of implementing new technologies. Understanding the fundamental principals must extend to the user level which is a significant change from existing practices. Once again understanding the fit between the technology and the application will increase the likelihood of success.

The second of the implemented initiatives was able to garner 15 benefits using a combination passive RFID in the area of decentralized warehouse management.

GOAL: The goal was to improve efficiencies of the warehouse management process for the handling of receipts and stowage of material thus lowering costs.

FIT: The attributes of RFID fit the application of warehouse management.

ENVIRONMENTAL ISSUES: Since this is taking place in a stable warehouse the environmental issues may exist but are stable and can be addressed. By modeling the warehouse and measuring the environmental electronic transmission this initiative is able to overcome the impact of the issues.

FUNCTION: This is consistent with the attributes of the technology.

FINDINGS: While they are 50% complete they are still in the testing stages. They have completed the redesign of the receiving operations to accommodate passive RFID.

OUR ANALYSIS: This initiative is part of the DOD initiative of implementing passive RFID into the inventory control points. It is good to see implementation going slowly with the business process' being created while the bugs are worked out in the lab. This initiative demonstrates that having the right fit, and taking a methodical approach can increase the benefits realized. Since the write up did not include hard data about operations and reports a 50% completion rate we assume the benefits are being derived from prototype demonstrations.

The final initiative to be discussed realized 18 out of 20 benefits utilizing all of the available technologies in the management of deployable equipment.

GOAL: The goal was automated tracking, monitoring and management of all assets through their life cycle.

FIT: Given the significant variability in the goal of this initiative the respondent has tried all available technologies choosing the best fit for each. The scope of this initiative is rather large, managing the deployment of over 13,000 individual parts, managing the return and repair of those same parts and maintaining the visibility as well. This initiative is leading edge on using technology and has added iridium modem with GPS to track the convoys overseas.

ENVIRONMENTAL ISSUES: Since this initiative is global in nature, the environmental issues are significant. It would appear that they are trying to address the issues by using multiple technologies to overcome shortcoming and exploit strengths.

FUNCTION: The scope of the project requires the user to implement all of the technologies taking into account the attributes of each. This user has made full use of the available arsenal.

FINDINGS: This initiative was able to demonstrate the different technologies and successfully deploy 13,000 line items.

OUR ANALYSIS: This initiative demonstrates again that fit is important. By utilizing all of the technologies and learning the capabilities and limitations the user was able to garner maximum results. A response of 15 would have averaged all supplied benefits with the last five being "other" responses. By claiming 18 they were able to garner all and three other benefits.

C. EVERYONE RECEIVES

Part B demonstrated that there is a clear line between success and failure when implementing technologies. Those who were best able to get the right fit between technology and application were able to gain the most benefits. Table 3 is the summary of benefits received from the participants in our survey. It is important to remember that although not all were able to find the right fit all were able to realize benefits. The least amount of benefits received were six, but those six were consistent with the function despite being in a poor fit. By recognizing that benefits are received by all, we should recognize that some benefit does not necessarily mean the initiative is working efficiently.

Process Improvement
# of Benefits received

5	Decreased complexity of operations
4	Increased ease of inventories
4	Increased accuracy of inventories
4	Increased speed of inventories
2	Other

Supply System Information
# of Benefits received

7	Increased timeliness of information
5	Increased visibility (requisition, shipment)
5	Increased availability of information
1	Increased accuracy of information inputted to AIS

Manpower Benefits
# of Benefits received

6	Increased worker productivity
4	Increased worker satisfaction
4	Increased worker utilization
1	Reduced physical labor

Parts Information
# of Benefits received

6	Increased amount of data available (history, age, location)
5	Increased ease of locating parts
4	Increased ease of part identification
1	Increased accuracy of the data available
1	Increased efficiency of returned parts back into inventory

Customer Service
# of Benefits received

7	Increased knowledge
5	Increased customer confidence (in the system)
5	Increased satisfaction
0	Other

Table 2. Summary of Findings

D. SUMMARY

In addressing the question: "Are there benefits outside of ROI in introducing RFID technologies?" we can overwhelmingly answer yes. The technologies are delivering some benefits universally even in situations where they are not really expected to work. We have demonstrated that applying the ideas of fit between technology attributes and the functionality required by an application we can help explain how to maximize benefits.

In the next chapter we will sum up our findings and provide some insights for those seeking to implement technology initiatives.

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VIII. CONCLUSIONS AND IMPLICATIONS

A. FINDINGS

"The life of the law has not been logic; it has been experience" Oliver Wendall Holmes, (Menand 1997). In this quote Menand explains that in the law, each case must take into account all of the variables. If the law were purely logical, then Bill Gates could write a program and put all of the lawyers and judges out of work. This idea fits well with the lessons learned from this study. Generally, RFID will present benefits to the adopter in most circumstances, but to maximize benefits one must address the variables. Those variables include the workforce, workspace, electronic interferences, monetary restrictions, previous experience (internal and external), etc. Only after considering all of the variables can a decision be made smartly.

In reviewing the data, there are some things that are readily apparent. All participants received value in terms of increases timeliness of information and increased customer knowledge. This knowledge in itself is helpful in addressing the issues facing the Navy today. In today's environment information is the key to timely decisions. The fact that all of the technologies provide more timely information and make the customer smarter is the first steps in re-establishing confidence in the Navy Supply System.

The most apparent finding in our data analysis was that success depends on knowing the attributes and limitations of the technology you are working with. By understanding the constraints of the technology and understanding the intended function of the technology a choice can be made that will result in the best fit. When the best fit is achieved ROI and intangible benefits will be more readily apparent.

B. IMPLICATIONS

When seeking to introduce technology to aid in addressing shortcomings of a process the following lessons learned can help to maximize the benefits received.

1. Thoroughly analyze the data from previous initiatives before introducing new technologies. The write ups in the NAVSUP BCA were very insightful to anyone thinking of trying a new technology.

2. Look for technology complements if possible. The NAVSUP BCA made a very good case for ease of transition for commands already using Bar Codes when looking at introducing Passive RFID. Commands that did not currently utilize Bar Codes would gain more benefit from introducing Passive RFID, but would be less prepared to do so.

3. Understand the objective of introducing new technology. ROI is a necessary evil, that is somewhat prohibited by the high costs of new technologies. In the mid 80's Wal-Mart launched its own satellite so all stores could talk to the Headquarters in Arkansas. This sort of initiative contributed to Wal-Mart becoming the leading retailer in the world. Increasing the timeliness of information and customer knowledge about where things are in the system are two very real objectives to introducing new technologies. Currently there has been no ROI calculation performed to prove it, but we feel that implementing these new technologies now will contribute to increasing benefits throughout the Supply Chain.

4. Accept the fact that there will be hurdles to overcome. The standard key to integration of a system into the Navy is selling the advantages of the technology, training the personnel on the system, creating schoolhouse training to support the system and finally implementing the technology across the board. Some problems arise when this process is not completed.

From a personal perspective two situations come to mind to illustrate this point. On one ship barcodes had never been used, despite being used on most other ships. In attempting to implement barcodes, they were amazed to find that none of the personnel had any experience with barcoding. In conducting the research to train the personnel, it was found that trainers would come to the ship and give the training. When they called to set up training, it turned out the training had been held there several years prior to the

inquiry. The point of the story is that high turnover of personnel requires system wide integration of a technology for it to really take root.

On the same ship, all of the SK's came off a carrier which used a different database than the current ship to maintain supply records. Although they had attended school, their capabilities with the system were marginal at best. They could produce the reports but did not have the in depth knowledge, developed over years of experience, that one would expect of their ranks.

These stories are provided to illustrate what happens when systems are not integrated to the Navy as a whole. That being said training on a Navy standard presents a unique challenge for RFID as well. As we have discussed, the drive to implement RFID into the Navy is not one size fits all, but rather specialized applications that address the unique challenges of each location. How then can training be addressed to provide skilled personnel for the Navy? We are presented with a challenge, a tradeoff between specialized local training and ease of training. The more localized the training, the harder it is to implement.

5. Consider all technologies when trying to address a problem. In the end a successful initiative depends on finding the right fit between technology and application while taking into account the environment in which it will operate. Given the volatile frequency environmental issues in the Navy today, perhaps the best way to get passive reads is by using active RFID. Active tags are able to overcome some of the shortcomings of passive RFID. In some situations, such as the submarine, passive reads may be desired but not practical.

We conclude with a reminder to all comers. Technology in itself is not the solution. Technology is an enabler which requires processes that enable the technology to help. As Supply Officer's we find these technologies offer a dream of passive reads delivering increased visibility and accountability. At this point they remain a dream. Business practices must exist which enable this dream to become a reality.

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